



Technology Infusion Plan

January 31, 2001

ESTO
Earth Science Technology Office

Prepared by:

_____ Date _____

Janice L. Buckner
ESTO/Technology Development Manager/Internal Programs

Signed by:

_____ Date _____

George J. Komar
Program Manager, Earth Science Technology Office

Approved by:

_____ Date _____

Granville Paules

Lead Technologist, Office of Earth Science

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1.0 Background

In the past, much of the technology development benefiting Earth Science missions was carried out within the framework of individual projects. This approach assured that the development activities were well focused on actual mission needs and, therefore, that there was a high likelihood the technologies would be used in the mission. However, the emphasis was necessarily on mission-specific advances that were needed to achieve required system performance, could be achieved in the relatively short period of time, and were evolutionary in nature to avoid unwarranted risk to the mission. Because cost-benefit trades were carried out within individual projects, there was little or no motivation to develop “generic” capabilities for the benefit of multiple missions, especially for missions that were not yet underway. Likewise, mission managers could not typically consider any breakthroughs that would require significant modification of flight or ground systems that a single mission could not afford. In general, a project could not afford to develop cost-saving technology unless the payoff exceeded the development investment within that project, and consequently technology development for the sake of cost reduction was rarely undertaken. This tended to perpetuate the use of older, less cost-effective engineering solutions and create a “technology-averse” design environment.

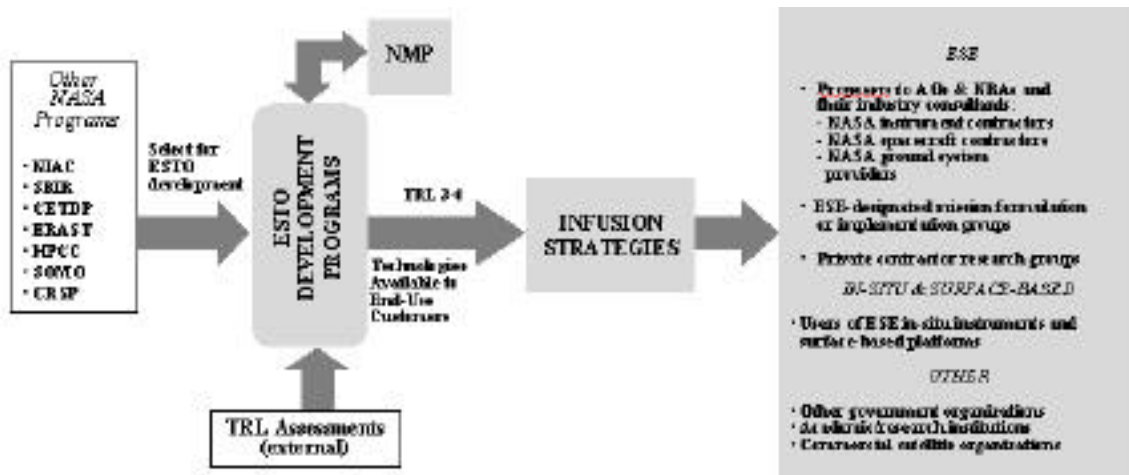
Following Agency guidance, the Office of Earth Science (OES) has adopted a new approach for technology development that establishes a more direct and strengthened linkage between science and technology, which then defines or benefits specific mission implementation. This model of “Science Objective -- Technology Options -- Mission Definition” offers a number of advantages over the traditional “ Science -- Mission -- Technology” paradigm in which technology was developed within the projects, and project-specific needs dictated priorities. By establishing the Earth Science Technology Office (ESTO, the OES consolidates the Enterprise technology program outside of the projects, and links it directly to Earth science objectives, and allows program priorities to be based on global optimization of the return on technology investment. This approach also enables ESTO to take advantage of synergistic opportunities for leveraging activities ongoing within the broader technology community, and to nurture breakthroughs that provide alternate, less expensive approaches to implement ongoing measurements, or enable new measurement.

However, separating the technology development from the projects also creates a new set of challenges for successfully infusing technology advances into future science missions to realize the benefits they offer. No longer is “buy in” by the projects automatic -- after all, the project manager did not make the decision to invest in these particular technologies. In fact, there is reason to be concerned as to whether they would even be aware of all pertinent performance and cost benefits offered by capabilities emerging from technology development programs external to their projects. This situation would appear to be exacerbated by the move towards principal investigator (PI) mode missions, in which decisions on which technologies to incorporate lie entirely in the hands of the PI’s, who are typically not resident at a NASA Center or directly involved in NASA technology programs.

2.0 Scope

This Technology Infusion Plan documents the technology infusion strategy for the Earth Science Enterprise (ESE). It is based on ESTO’s Integrated Technology Development Plan (ITDP) which describes the Earth Science Technology Program along with fiscal year budget allocations. It also describes methods of broadly disseminating information regarding capabilities and maturity of new technologies. Additionally, this plan describes ESTO’s Annual Technology Conference and Annual Report publication. It shows how ESTO supports OES mission formulation teams with technologies that reduce development time, and minimize program cost. It identifies website resources that describe current technology investments made to enable future Earth Science measurements, and introduces a technology infusion tool that identifies technologies available for technology infusion. This plan is the input to the development of candidate flight measurements profiles prepared through HOWI-7120-Y003, *Formulate and Approve Flight Missions*. This plan, and the approved flight measurement profile, will provide a major input to the next technology development planning cycle. This document is prepared by ESTO, with input from other technology strategy team members, as appropriate, for Lead Technologist approval.

Figure 1. Technology Infusion Flow Diagram



3.0 What is Technology Infusion?

Technology infusion is the process of taking activities which lead to new and lower-cost scientific missions and investigations, and ensuring their availability to the Earth Science user community.

4.0 Technology Infusion Strategy

ESTO has identified, and will implement, appropriate new strategies to ensure that new technologies are available for infusion into future Earth Science missions. ESTO is creating an environment in which it is in the best interest of the Earth Science end user community to adopt new technologies. The following diagram illustrates ESTO's technology infusion flow diagram. ESTO will invest in technologies that offer significant cost savings and/or performance enhancement in high priority science areas. ESTO believes that incorporating these advantages into mission designs will increase the PI's chance of generating a winning proposal and should, in turn, serve as a strong motivator for proposers to take advantage of the new capabilities in designing their missions, as long as the new technologies do not introduce unwarranted levels of risk into their mission design. To realize this scenario, ESTO shall ensure that information on capabilities and maturity of new technologies is broadly disseminated to reach the appropriate user communities, that the technologies are valuable and truly available for use and incorporation, and that the associated risk to the first user is appropriately mitigated. ESTO's development programs rely on technology advancements in other NASA programs, verification and technology assessments from other organizations, and coordinated feedback from the technology end user.

4.1 Dissemination of New Technology Information

Understanding that the goal for Earth Science measurement acquisition timelines is three years or less, the ESE users community will necessarily rely on technologies that are already available at the beginning of the mission design. However, to incorporate new technologies, they must first be aware of these emerging advances. Thus, adequate information dissemination is an important step towards technology infusion. This plan describes appropriate dissemination vehicles that will be used by ESTO to reach the entire range of potential Earth Science customers and their industrial partners.

4.1.1 Annual Technology Conference

ESTO will hold an annual Earth Science Technology Conference. This conference provides an opportunity for the Earth Science community, to come together and share the results of technology research that impact the ESE. This audience will include all NASA, Industry and Academia scientists, instrument and spacecraft developers, and information systems persons interested in the mission enabling technologies of the ESE. It will serve as an open forum where all technologies invested in by ESTO, over the past year, will be discussed, and it will have the added value of providing visibility to all prospective users of the technologies. This annual conference will promote the infusion of these technologies into ESE measurement missions.

4.1.2 Earth Science Technology Annual Report

ESTO will publish an annual technical report. This publication will contain a brief description of the array of technology investments in the Instrument Incubator Program (IIP), Advanced Information Systems Technology (AIST) Program, and the Advanced Technology Initiatives (ATI) Programs. It will also showcase technology partnerships that have been established between ESTO and Small Business Innovative Research (SBIR) program, Space Based Technology Program (formally known as the CETDP), SOMO, and various other technology development programs.

4.1.3 Support of ESE Mission Formulation

ESTO staff members shall become active team members of the various ESE mission formulation teams. ESTO representatives will attend mission formulation team meetings, review data specification requirements, and identify technology challenges. The ESTO representative will research current technology development programs in search of technology solutions that will provide performance benefits over existing or currently planned technologies. ESTO representatives will endeavor to identify technologies that reduces risk, cost, size and development time of Earth observing instruments, platforms, or information systems.

4.1.4. Technology Websites for the Earth Science Enterprise

ESTO will further make technology investment information available to the end user customer through the use of the NASA Earth Science Enterprise Technology Integrated Planning Systems (TIPS). The purpose of TIPS is to document the full scope of the Earth Science needs, technology investments, technology customers, roadmaps, etc. This database currently contains technology development underway in the ATI, and AIST programs. ESTO plans to link this database to the NASA Technology Inventory, which includes the results of other technology development programs, such as SBIR/STTR and Space Based Technology Program. Together these databases represent an overall investment of about \$2 billion encompassing small, but far reaching, innovative tasks ripe for infusion into industry and specific space flight applications. These databases will be made available on the ESTO homepage at <http://esto.gsfc.nasa.gov>. These websites are updated regularly to provide the latest information available.

4.1.5 Technology Infusion Schedule

In order for the PI to infuse technologies into mission designs they must know what technologies are available for use. In most instances the PI will choose against the use of new technologies because they are not mature or have not been sufficiently validated. The technology infusion schedule is a software planning tool that will allow the end user to identify promising new technologies in the pipeline that will enable new mission designs. The beta 1 version of this tool will identify technologies currently funded in the IIP, ATI, AIST, and ESTO partnering technologies. The beta 2 version will interface with the NASA Technology Inventory

Technology Infusion Schedule

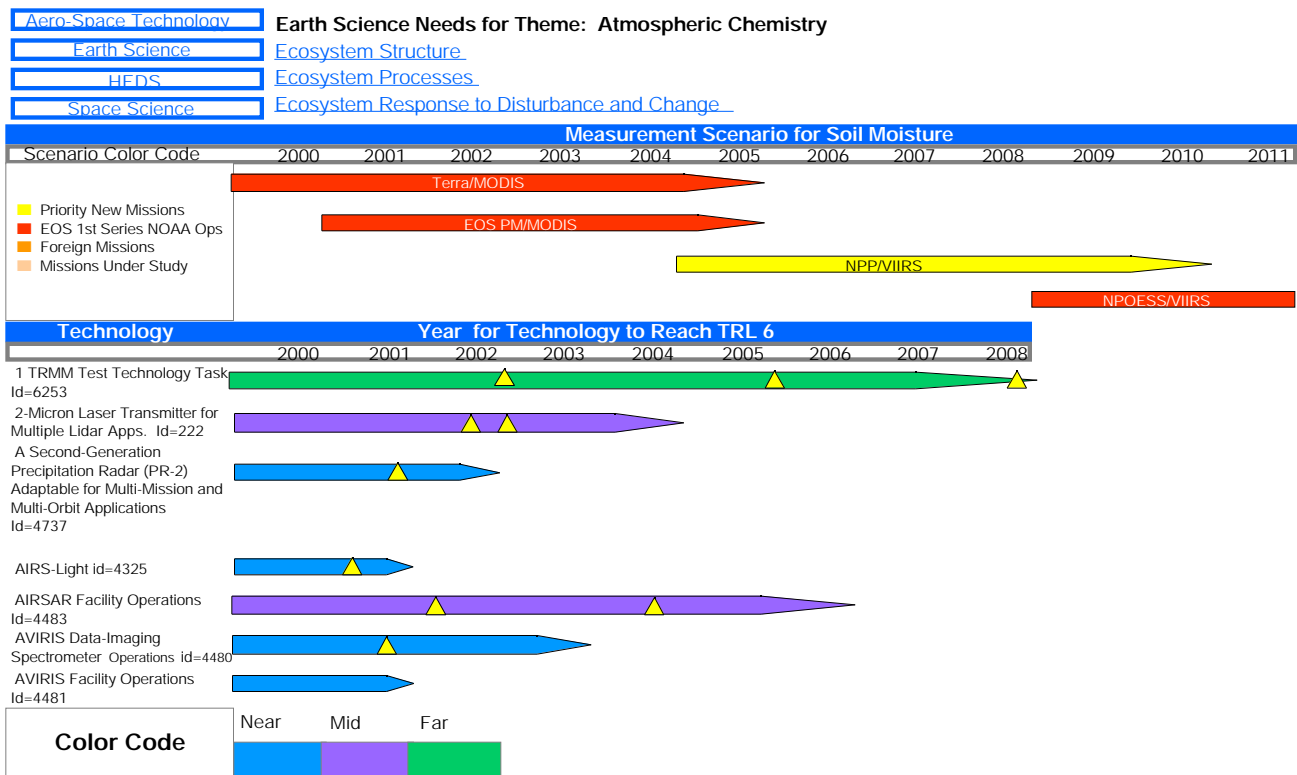


Figure 2 Technology Infusion Schedule Example

database which will expand the scope to include technology development programs throughout the agency. Figure 2 is an example of the technology infusion schedule. . The technology infusion schedule is available on the ESTO homepage at <http://esto.gsfc.nasa.gov>.

4.2 Maturity and Risk

With future mission acquisitions striving to achieve 3-year timelines, technology to be selected for mission incorporation must be sufficiently mature and well understood so that it can be integrated with other spacecraft systems without significant further development. It must also be appropriately validated such that the remaining risk associated with its first use is acceptable, not only to the proposer, but also to review committees. Technology validation will allow the Earth Science user community to have confidence in the new technology. As a result, the user will

have the ability to incorporate it into a proposal because they can anticipate that a review committee will embrace the technology risk. In some cases, full-up operational validation in a space environment may be required to retire unacceptable levels of risk. To retire risk, ESTO plans to validate these technologies in the New Millennium Program. The technology readiness, including performance verification and appropriate validation test results, will be well documented and made easily available to both the end user and the reviewer community.

5.0 Technology Availability to Industry

If technology is to be available for many future missions, it is critical, once feasibility has been demonstrated, to transfer the technology to one or more industrial providers. This is particularly true for spacecraft or ground systems, especially because ESTO expects to rely on commercially available systems as a method of lowering future mission costs. Instrument and platform technologies will be transferred to aerospace companies where they can be incorporated into systems that can be made commercially available to aerospace companies who fabricate NASA instrumentation and platform systems for Earth Science mission measurements. A similar approach will be established for advanced information systems in support of innovative flight and ground data systems. For specialized, but scientifically critical components or subsystems that will only be required in relatively small numbers, it may be acceptable to maintain a fabrication capability at a university or NASA Center, provided support is continued to ensure that the technology will be available when needed.

6.0 ESTO Roles and Responsibilities

Table 1 summarizes ESTO's roles and responsibilities for the infusion of technologies that benefit the Earth Science Enterprise.

ESTO is Responsible	ESTO is not Responsible
Technology Description – Available in the Annual Report and the TIPS database	Commercialization – ESTO is not responsible for the commercialization of new technologies
Briefings/Workshops – ESTO Annual Technology Conference	Hardware and Software Deliverable – ESTO is not the customer of hardware and software deliverables
Investments in ESE Technologies – Controlled by the annual IIP, AIST, and ATI NRA process and established technology partnerships	
Technologies Available for Infusion – Identified in the Technology Infusion Schedule	
Technology Transfer – ESTO will identify technologies ready for transfer	

Table 6.0. ESTO Roles and Responsibilities for Technology Infusion